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وزارة التعليم العالي والبحث العلمي

جامعة ديالى / كليــة العلوم

قسم علوم الحاسوب

نموذج الكشف عن الحرائق باستخدام تقنية التعلم العميق

رســالة

مقدمة الى قسم علوم الحاسوب / كلية العلوم / جامعة ديالى وهي جزء من متطلبات نيل درجة الماجستير في علوم الحاسوب

من قبل

أيسر سعد عبدالستار

بإشراف

أ. ناجي مطر سحيب

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Chapter One

General Introduction

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1.1 Overview

Abnormal events represent the most serious threat to human life, such as floods, earthquakes, accidents - combat, medical emergencies, and fires, which lead to a threat to safety and public health. Fires are the most common to other events [1]. The timely detection of fire or smoke is of utmost importance in order to enable prompt intervention and prevent extensive damage. Numerous techniques and instruments have been employed to detect the presence of fire or smoke in visual imagery. The majority of conventional detection techniques employ instruments and sensors that are designed to identify the existence of smoke or flame [2].

All traditional methods of early warning of fires have major drawbacks because they are prone to malfunctions, require regular maintenance, can only identify flames or flames near places where installed in it, and do not provide sufficient information about the direction of the fire, its initial location, size and many other defects [3].

The shortcomings of conventional approaches were addressed by a number of video and image-based solutions. These methods make use of photos and videos that cameras, which may be deployed in any interior setting, have produced[4]. Additionally, the external system may determine whether a pixel is smoke or not using a variety of methods, such as the color-based static decision rule and the diffusion-based dynamic choice rule [5]. Also, there are techniques that use blurring boundaries and flare to detect fire and flames, as well as the video-based luminous flux technique [6].

The primary objective of the aforementioned techniques is to create a rule-based algorithm that depends on predetermined human-crafted characteristics or specialized expertise, which serve as the principal indicators of smoke and fire, contingent upon various factors such as composition, texture, color, and motion. This renders the task intricate and challenging. In order for these algorithms to achieve high accuracy, in recent years another approach has been used to achieve a step towards detecting fires in videos and images with the help of machine learning and deep learning. In the deep learning approach, artificial neural networks were used, which achieved exceptional goals in different cases. In addition to computer vision to overcome the shortcomings of the current regulation and provide a correct and accurate fire detection system as quickly as possible and is able to operate in a variety of environments and can detect and extract important features of color and smoke in images and videos. Deep learning, especially convolutional neural network (CNN), has effectively contributed to fire detection and achieved excellent results in solving visual recognition problems [7].

Employed a convolutional neural network (CNN) and Support Vector Machines (SVM) methodology to identify occurrences fires in the (fire_detection_dataset). The You Only Look Once (YOLO) network is a deep learning technology that was introduced in 2015 and widely adopted in 2016. It was developed by Joseph Redmon, who created a comprehensive network for this purpose [8].

Related work

In recent years, studies and research have begun to apply computer techniques to detect fires, and we mention the following:

- **Sebastien Frizzi et al. (2016):** The usefulness of deep learning target detection technology to identify forest fires was shown by the use of the convolutional neural network (CNN) to detect fires by segmenting the full picture into numerous tiny sections, accuracy reaches (81%) [9].
- **Zhang Qixing et al. (2018):** A proposed methodology involves augmenting the training set by extending the synthetic smoke image. Based on this premise, the implementation of Fast-RCNN smoke detection was proposed. Nonetheless, the utilization of the aforementioned technique is restricted to stationary data within a singular image, thereby limiting the overall system's capacity for generalization accuracy reaches (85%) [10].
- **Shin et al. (2018):** Detection of flames in images and videos through the method proposed in this paper, which is deep learning using YOLO. Leveraging an optimized YOLO flame detection model from video frames, data collection, and training using Google Tensor Flow platform, the obtained flame detection accuracy reaches (76%) [11] .
- **Zhentian Jiao et al. (2019):** With the aid of YOLOv3, In this work, CNN was used. The results of the tests show that this algorithm has a detection frame rate of more than 3.2 fps and a recognition rate of almost 83%.. Real-time forest fire detection applications employing this technique have several benefits [12].
- **Guohua Wang et al. (2020):** this proposed method employs dynamic background modeling and deep learning to avoid the unreal alarms of smoke and SVM is used to complete the detection of smoke. Despite of its effectiveness, this system showed instability in complex outdoor scenes, accuracy reaches (83%) [13].
- **Rui Valente de Almeida et al. (2020):** To find forest fires, the commercial technology Bee2Fire was introduced. Regular cameras and deep artificial neural

networks will be used to fight fires. After training this network, it uses the picture classification method to look for smoke plumes over the horizon. The precision was (82%) [14].

- **Raghad K. Mohammed. (2020):** In this work , they used a pre-trained Inception-ResNet-v2 network on the Image Net dataset to be trained on our dataset which consists of 1,102 images for each fire and smoke class. The classification accuracy, precision, recall, F1-Score, and specificity were 99.09%, 100%, 98.08%, 99.09%, and 98.30%, respectively. This model has been deployed on a Raspberry Pi device with a camera. For real-time detection, they used the Open CV library to read the camera stream frame by frame and predict the probability of fire or smoke[15].
- **R. Xu et al. (2021):** This study presents a novel ensemble learning approach for detecting forest fires in diverse settings. Specifically, the proposed method combines two distinct learners, namely Yolo v5 and Efficient Net, to enhance the accuracy of the fire detection process. An additional scenario involves the utilization of the Efficient Net by individual learners to mitigate the occurrence of false positives. The detection efficacy demonstrated an enhancement ranging from 2.5% to 10.9%, while the occurrence of false positives was mitigated by 51.3%, without any concomitant increase in delay time [16].
- **Wijdan Yunes, (2022):** In this work, the features are extracted from the fire images, then an input to one of the classification methods, which depends on the method of deep learning using the Convolutional Neural Network (CNN), which is one of the modern technologies in recent years, the movement of the flame is detected after segmenting the images and then labeling them in order to extracting the shape of the flame. In general, this work aims, to detect fire and flames in images by acquiring video files using regular surveillance cameras, and then the process of classification and detection is carried out with the applications of deep

learning algorithms (classification using deep learning method), this technique provides a higher degree of accuracy up to (86%)[7].

- **Seyd. Teymoor seydi et al. (2022):** To detect active fires and biomass burning, they suggested a deep learning framework called Fire - Net Imagery-trained Landsat-8, which blends visual (red, green, and blue) and thermal methods from photos to produce a more accurate representation. In addition, residual warp blocks and warp blocks were utilized. separable data allowing deeper features to be extracted from the dataset, this technique provides a higher degree of accuracy up to (83%) [17].

1.2 Problem statement

Fire accidents pose a serious threat to industries and densely populated areas observed all over the world, resulting in material and human losses. There are old classic ways to detect fires before they occur, and they all depend on devices and sensors, and these methods contain many problems, including:

- Hardware systems that are prone to breakdowns and need periodic maintenance.
- Systems are expensive.
- False alarms.
- The sensors cannot be used in hot industrial conditions.
- The sensors' efficacy in large, enclosed spaces is limited since they typically can only detect fire or flames close to the locations where they are mounted.

• Flame or smoke sensors are insufficient for determining the magnitude, direction, or initial location of a fire.

As a result of the development taking place in the field of computers and the use of artificial intelligence, many researches and studies appeared that dealt with this issue and addressed the weaknesses in the classical methods based on machine

learning and deep learning techniques, and based on images and videos taken from surveillance cameras or satellites, but this research still suffers from many problems . Including them with regard to efficiency and speed, as well as relying on features for flames, smoke, or otherwise.

1.3 Aim of the Thesis

The work aims to design and implement an external fire detection system that addresses the problems that were addressed in the previous item, depending on the.

1- Image using surveillance cameras.
2- Extract features from images and then enter them into classification methods that rely on deep learning using Convolutional neural network (CNN) which is one of the new technologies in recent years.

3- The Support Vector Machine (SVM) is the second approach to classifying fire and non-fire images.

4- The You Only You Look One (YOLOv5s) network, is the third way to categorize both fire and non-fire photos.

The aim of using more feasible information is to improve detection with accurate fire detection and to give reliability in decision making and rapid-fire detection.

1.4 Outline of thesis

The thesis consists of five chapters, starting with the first chapter, which includes a comprehensive introduction to the detection and classification of fires, as well as an account of previous studies conducted on the subject and the objective of the thesis.

Chapter 2: This chapter includes a review of the theoretical side of the concepts. Techniques and algorithms used in the design and implementation of the proposed system, where the concepts of deep learning, the algorithm (CNN) and You Only Look Once (YOLO) network, as well as machine learning, the algorithm (SVM) and some statistical concepts used in the tests were addressed.

Chapter 3: This chapter includes the design of the proposed system with a review of its entities and their explanation in detail along with the algorithms and techniques used.

Chapter 4: This chapter includes a review of the results of the implementation of the proposed system. Where the detailed results of the system were presented with analysis, tests, and comparisons with other studies.

Chapter 5: This chapter includes the conclusions obtained from the design and implementation of the proposed system as well as presenting future work.

الملخص

في الآونة الأخيرة ، ونتيجة لتغير الطقس ، وارتفاع درجات الحرارة ، وكثرة المعامل ، والكثافة البشرية ، والاستخدامات غير الصحيحة لوسائل الطاقة ، حدثت وتحدث يوميًا في جميع دول العالم حرائق، مما تسبب في خسائر مادية وبشرية. ولتجنب الكوارث في هذا المجال ، يجب استخدام وسائل للكشف عن الحرائق .

نتيجة للتطور الحاصل في مجال الكومبيوتر واستخدام الذكاء الاصطناعي ، ظهرت العديد من الأبحاث والدراسات التي تناولت هذه القضية وعالجت نقاط الضعف في الأساليب الكلاسيكية القائمة على التعلم الآلي وتقنيات التعلم العميق ، والقائمة على الصور ومقاطع الفيديو المأخوذة من كاميرات المراقبة أو الأقمار الصناعية ، لكن هذه الابحاث مازالت تعاني من مشاكل كثيرة. من حيث الكفاءة والسرعة.

في هذا العمل تم الاعتماد على خوارزميات الذكاء الاصطناعي (SVM و CNN و YOLO5s) لبناء نظام يهدف الى كشف الحرائق بالأعتماد على الصور والفيديو. يعمل نموذج التعلم الالي SVM بكفاءة تصل الى 69% .ويعمل نوذج التعلم العميق CNN بكفاءة بناءا على دقة تصل الى (90%). وبلغ أفضل معدل لاكتشاف اللهب في خوارزمية YOLO5vs هو (87%).